

# Xerographic Copiers

## Introductory Question

- You are covered with static electricity. If you hold a sharp pin in your hand as you reach out for a doorknob, the pin will
  - A. make the shock you'll get worse
  - B. make the shock you'll get weaker
  - C. leave the shock you'll get unchanged

## Observations About Copiers

- Copies consist of colored powder stuck to paper
- After jams, the powder sometimes wipes off
- Copiers run out of colored powder or "toner"
- Copies are often warm after being made
- Copies tend to be staticy and clingy
- Some copiers scan a light, some use a flash

## 3 Questions about Xerographic Copiers

- How can light arrange colored powder on paper?
- How does a copier spray charge onto a surface?
- How does a copier make its copies permanent?

## Question 1

- How can light arrange colored powder on paper?

## The Xerographic Concept

- The xerographic concept
  - sprays electric charge onto a surface and
  - projects an image of the document onto that surface.
  - Wherever light hits the surface, the charge escapes.
  - The remaining charge attracts colored toner particles
  - which are then bonded to paper to produce a copy.
- The surface is a photoconductor,
  - an insulator that turns into a conductor in the light,
  - so illumination allows charge to move and escape.

## Question 2

- How does a copier spray charge onto a surface?

## Electric Fields (Part 1)

- Consider these two views of electric forces:
  - The first view is charge-on-charge
    - Charge<sub>1</sub> pushes directly on Charge<sub>2</sub>.
  - The second view is charge-electric field-charge
    - Charge<sub>1</sub> creates an electric field
    - That electric field pushes on Charge<sub>2</sub>.
- This electric field isn't a fiction; it actually exists!

## Electric Fields (Part 2)

- An electric field
  - is a structure in space that pushes on electric charge
  - is vector in character: it has magnitude and direction
  - may depend on position and time
- The electric field at a given position and time
  - is proportional to the force on a + test charge
  - is often represented graphically by an arrow
  - but is actually located at just one point on that arrow

## Clicker Question

- To determine the electric field at the tip of your nose, you could throw a + test charge past your nose and, ignoring gravity, measure
  - its velocity at the tip of your nose.
  - its position at the tip of your nose.
  - its acceleration at the tip of your nose.
  - its mass at the tip of your nose

## Electric Fields and...

- Consider these two views of electric forces:
  - The first view is electric field-on-charge
    - An electric field exerts a force on a + test charge

## ...Voltage Gradients

- The second view is voltage gradient-on-charge
  - An object accelerates to reduce potential energy (PE)
  - so it experiences a force down the "gradient" of PE
  - + test charge has electrostatic potential energy (EPE)
  - + test charge's EPE is proportional to its voltage
  - + test charge experiences force down voltage gradient
  - A voltage gradient exerts a force on a + test charge
- A voltage gradient *is* an electric field!

### Clicker Question

- Many of the yellow glowing particles in a candle flame are positively charged. If you place the flame between two plates, one with a higher voltage than the other, the flame will
- A. bend toward the lower voltage plate.
  - B. bend toward the higher voltage plate.
  - C. be squished downward toward the candle.
  - D. be stretched upward away from the candle.

### Electric Fields In and Around Metals

- Inside a metal, charges can move freely
  - and can rearrange to minimize their EPE.
  - At equilibrium, the metal has a uniform voltage,
  - and there is no electric field inside the metal.
- Outside a metal, charges can't move freely,
  - so they cannot rearrange to minimize their EPE.
  - At equilibrium, voltages can vary with location,
  - and there can be an electric field outside the metal.

### Corona Discharges

- Outside a sharp or narrow metal at high voltage,
  - the voltage varies rapidly with position,
  - so that the electric field is very strong
  - and it can push charges onto passing air particles.
- This phenomenon is a corona discharge
  - in which the narrow metal sprays charges
  - and can easily deposit or dissipate static electricity.

### Clicker Question

- If I attach an upward pointing metal pin to the top of the van de Graaff generator, it will accumulate
- A. more charge than before.
  - B. less charge than before.
  - C. the same charge as before.

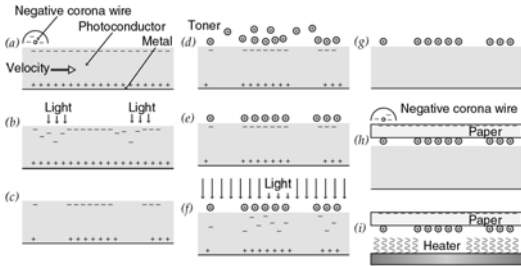
### Introductory Question (revisited)

- You are covered with static electricity. If you hold a sharp pin in your hand as you reach out for a doorknob, the pin will
- A. make the shock you'll get worse
  - B. make the shock you'll get weaker
  - C. leave the shock you'll get unchanged

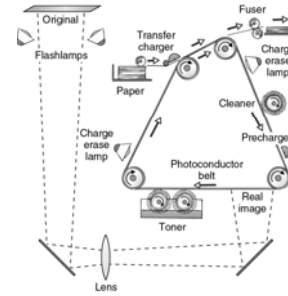
### Question 3

- How does a copier make its copies permanent?

## Xerographic Process



## Copier Structure



## Summary about Xerographic Copiers

- It sprays charge from a corona discharge
- That charge precoats a photoconductor
- It projects a light onto the photoconductor
- The charge escapes from illuminated regions
- The remaining charge attract toner particles
- Those particles are fused to the paper as a copy